Claims

1. **A wrist position method** for non-invasive blood pressure measurement, at least placing an arterial pulse transducer on the skin over the radial artery of the wrist to detect pulse signal of radial artery, wherein at least the angle between the hand and the wrist is kept to the most suitable degree for measuring the blood pressure of the radial artery, such an angle is capable of lowering the position of the tendon and causing the radial artery to reach close to the radius.
2. A method as defined in **claim 1** wherein said the suitable angle between the dorsal side of the hand and the dorsal side of the wrist is preferably a angle of 100 – 170 degrees when measuring blood pressure on the radial artery.
3. A method as defined in **claim 1** wherein the turning angle of the wrist relative to the middle part of the forearm is kept to the most suitable degree for measuring the blood pressure of the radial artery, such an angle can also cause the radial artery to reach close to the radius.
4. A method as defined in **claim 3** wherein said the turning angle of the wrist relative to the middle part of the forearm is preferably a turning angle of 30 – 100 degrees formed by turning inward palm side of the wrist relative to the part of the forearm close to the elbow joint.

5. **A non-invasive blood pressure measurment method** with the wrist position method as defined in **claim 1**, comprising the steps of,
   (1) placing at least a pressure bladder and an arterial pulse transducer array on the skin over the crossing of radial artery and the most protuberant spot on the volar aspect of the distal end of the radius, and keeping the position of said transducer and pressure bladder relative to the site to remain unchanged;
   (2) controlling the change of pressure of the pressure bladder within the range between the lower limit below the possible mean blood pressure and the upper limit above the possible systolic blood pressure of the subject;
   (3) detecting the pulse signals of the radial artery by said arterial pulse transducer array from various sites of the wrist along with the pressure change of said pressure bladder, and feeding the pulse signals to a optimal pulse selector to find the optimal measuring site with the optimal pressure transmission on the wrist; due to the amplitude of the pulse signal measured by the transducer near the radial artery being large, and the mean and systolic blood pressure corresponding to the pulse signal measured on the site with the accurate pressure transmission being lower, the optimal site selecting method comprise: first, choosing a column of the pulse signal with

the largest amplitude during the maximum oscillation among all the columns of the pulse signals detected from those transducers arranged parallel to the radial artery in the array; secondly, choosing a channel of the pulse signal from the selected columns of the pulse signals, said selected signal possessing not only maximum oscillation through the entire pressure changing process of the pressure bladder, but also being closed to disappearance during the bladder pressure is higher than the pressure corresponding to the maximum oscillation, and the bladder pressures corresponding to the maximum and the disappearance of oscillation of the selected signal being the lowest; finally, said selected signal being used as the optimal pulse signal;

(4) employing said optimal pulse signal to non-invasive blood pressure measurement.

6. A method as defined in **claim 5** wherein said pulse transducer array is preferably placed at the center of the pressure area of said pressure bladder so that, when the transducer measured the optimal pulse signal is at the center of said pulse transducer array, the site with accurate pressure transmission can correspond to said pressure area center where the pressure can be transmitted most deeply.

7. A method as defined in **claim 6** wherein the position of the transducer measured the optimal pulse signal in the array is displayed in the most visual way; and when setting said pressure bladder, the position of said pressure bladder is adjusted according the display to make the transducer measured the optimal pulse signal to be at the center of said pulse transducer array.

8. A method as defined in **claim 7** wherein it is detected automatically whether the transducer measured the optimal pulse signal is at the center of said pulse transducer array or not, and if the distortion is too far from said center, a warning signal is given for repositioning of said pressure bladder.

9. A method as defined in **claim 5** wherein said pulse transducer array is preferably placed on the inside of the wall of said pressure bladder which faces the wrist, so that said pressure bladder can press evenly the surface of the wrist.

10. A method as defined in **claim 5** wherein the hand is slightly turned towards the little finger to form an angle of 10 – 40 degrees between the centerline of the hand and the centerline of the palm side of the wrist, so that the protuberant spot at the end of the root segment below the thumb does not obstruct the bladder holding strap to cling to the wrist.

11. A method as defined in **claim 5** wherein the difference between the diameters of the wrist joint section and that of middle part of the forearm is

eliminated, and the sinking surface of the wrist joint part due to the hand bending is filled to a regular column surface to avoid said pressure bladder shifting towards the hand along the long axis of the wrist during the inflation of said pressure bladder.

12. A method as defined in **claim 5** wherein the interface area between the wrist and the holding devices for both the pressure bladder and the wrist is made to be as large as possible, so as to minimize the pressure from the holding devices on to other areas of the wrist during the inflation of said pressure bladder.

13. A method as defined in **claim 5** wherein said optimal pulse signal is used for non-invasive intermittent measurement of the mean and systolic blood pressure of the radial artery with volume oscillometric method.

14. A method as defined in **claim 5** wherein said optimal pulse signal is used for non-invasive continuous measurement of the blood pressure wave of the radial artery with volume compensation method.

15. A method as defined in **claim 5** wherein said optimal pulse signal is used alternately for non-invasive intermittent measurement of the mean and systolic blood pressure of the radial artery with volume oscillometric method, and non-invasive continuous measurement of the blood pressure wave of the radial artery with volume compensation method.

16. A method as defined in **claim 5** wherein said pressure bladder and arterial pulse transducer array are placed on the radial artery and the ulnar artery respectively so that the blood pressure can be alternately measured from the two arteries.

17. A method as defined in **claim 16** wherein said ulnar arterial pulse transducer can also be parallel-connected photoelectric sensors, and it is preferred to place more than two such parallel-connected photoelectric sensors vertical to the ulnar artery, within the pressure area of the ulnar arterial pressure bladder.

18. A method as defined in **claim 16** wherein the result of the blood pressure measured from the radial artery is used as the standard for calibrating the result measured from the ulnar artery.

19. A method as defined in **claim 16** wherein said method using the result of blood pressure measured from radial artery to calibrate the result measured from the ulnar artery comprise: calculating the difference (Di) between the mean blood pressure measured from the radial artery and the bladder pressure of ulnar artery corresponding to the maximum pulse amplitude of ulnar arterial pulse, and calculating the ratio (Pi) of the ulnar arterial pulse amplitude to the maximum amplitude of the ulnar arterial pulse when the bladder pressure of ulnar artery is equal to the systolic blood pressure measured from the radial artery; so that, each time thereafter, the

new mean blood pressure of ulnar artery can be obtained by subtracting Di from the bladder pressure of ulnar artery corresponding the maximum amplitude of measured ulnar arterial pulse, and the new systolic blood pressure of ulnar artery can also be obtained by measuring the bladder pressure of ulnar artery when the ulnar arterial pulse amplitude with the Pi ratio to its maximum amplitude during the bladder pressure of ulnar artery is higher than the new mean blood pressure of ulnar artery.

20. A method as defined in **claim 19** wherein, when using the result of blood pressure measured from radial artery to calibrate the result measured from the ulnar artery, said two pressure bladders are interconnected by their tubing to measure the blood pressure from both the radial artery and the ulnar artery simultaneously with volume oscillometric method.

21. A method as defined in **claim 19** wherein, when using the blood pressure measured from radial artery to calibrate the blood pressure measured from the ulnar artery, said procedures of measuring blood pressure from the radial artery and from the ulnar artery are separated one after the other.

22. A method as defined in **claim 16** or **claim 18** or **claim 19** wherein said **Di** and **Pi** are recalculated automatically during a long-term, continuous measurement of blood pressure.

23. A method as defined in **claim 5** wherein other criterion, such as the changes in the shape or the base-line level of the pulse waveform, the changes in the amplitude of minor oscillation added artificially on the pulse waveform, the change in the speed of the blood flow, etc. can be used to evaluate the unloading state of the artery to be measured, and hydraulic pressure can also be used to control the external pressure of the artery, and also other types of volume sensitive means can be used for measuring the arterial pulse.

24. **A wrist detecting assembly** for non-invasive blood pressure measurement, at least comprising a pressure bladder placed on the skin over either the radial artery or the ulnar artery by a holding means, wherein at least an arterial pulse transducer array is placed within the pressure area of said pressure bladder.

25. A device as defined in **claim 24** wherein the shape of the pressure area of said pressure bladder is preferably circular, the diameter of which should be 1/3 – 3/5 of that of the wrist, and the wall of said pressure bladder which closes to the wrist should be made with resilient membrane shaped to shaped to upheave towards the wrist, and the wall along the circumference and the outer wall of said pressure bladder should be made of rigid material.

26. A device as defined in **claim 24** wherein the pulse transducer in said arterial pulse transducer array is preferably the reflective photoelectric transducer that consists of light emitting devices and photoelectric devices, and the preferred structure of which should be composed of a rectangle array of photoelectric devices arranged close to each other and light emitting devices arranged around the rectangle array, and also, excepting the side against the skin, all other sides of the photoelectric devices are shielded with light-blocking material.

27. A device as defined in **claim 26** wherein there are at least two photoelectric devices arranged both parallel to and vertical to the radial artery respectively, and each device outputs a channel of pulse signal of the radial artery.

28. A device as defined in **claim 26** wherein said arterial pulse transducer array should be preferably placed on the inside of the wall of said pressure bladder which closes to the wrist, and the light emitting surface of the light emitting devices and the light receiving surface of the photoelectric devices should face the inner surface of said bladder wall, and the center of the photoelectric device array should correspond to the center of said bladder wall.

29. A device as defined in **claim 28** wherein the membrane of said bladder wall close to the wrist, at lest its region with arterial pulse transducer array, should be translucent.

30. A device as defined in **claim 24** wherein said bladder holding device is preferably a ring-shaped strap made of material with higher rigidity and a little elasticity, the diameter of which is close to that of the wrist, and two ends of the opening of said strap at the back side of the wrist should be connected by non-extensible mean.

31. A device as defined in **claim 30** wherein the width of said ring-shaped strap is preferably larger than the diameter of the wrist, and the side of said ring-shaped strap in contact with the wrist should have the contours that match the shape of the wrist.

32. A device as defined in **claim 30** wherein said pressure bladder and said ring-shaped strap can be integrated into a whole, which is made by using a strap with certain thickness, and being processed a flat, circular delve whose diameter is the same as that of said pressure bladder on the wrist side of said strap in a position corresponding to radial artery, and the edge of the said bladder wall made with resilient membrane is glued to the edge of circular delve of said strap.

33. A device as defined in **claim 24** wherein the wrist holding bracket is required preferably, said wrist holding bracket is a curved board made of material with high rigidity, its length and width should cover the dorsal side

of the hand, the dorsal side of the wrist, and the dorsal side of forearm close to the elbow, its shape should make the dorsal side of the hand to form an angle of 100 – 170 degrees against the dorsal side of the wrist, and cause the palm side of the wrist to form an inward turning angle of 30 – 100 degrees against the palm side of the part close to the elbow, and preferably also cause the centerline of the hand to form a turning angle toward the little finger against the centerline of the palm side of the wrist.

34. A device as defined in **claim 33** wherein the thickness of said wrist holding bracket in the part connecting the dorsal side of the hand and the dorsal side of the wrist is increased, so as to eliminate the difference between the diameters of the wrist joint section and that of middle part of the forearm, and to fill the sinking surface of the dorsal side of wrist joint part due to the hand bending to a regular column surface.

35. A device as defined in **claim 33** wherein the inside of said wrist holding bracket should be shaped to matches well with the scraggly contour of the dorsal side of the wrist.

36. A device as defined in **claim 33** wherein there are fastening devices for holding the arm and the hand on said wrist holding bracket.

37. A device as defined in **claim 24** wherein said pressure bladder and arterial pulse transducer can be placed on both the radial artery and the ulnar artery respectively, a switching device is used to control the two pressure bladders and the two arterial pulse transducers to alternately apply the external pressure to both the radial artery and the ulnar artery, and detect volume pulsation signals from both the radial artery and the ulnar artery.

38. A device as defined in **claim 37** wherein said ulnar arterial pulse transducer, arranged vertical to the ulnar artery, is preferably made of more than two photoelectric devices placed close to each other, and such photoelectric devices are parallel- connected so as to outputs one channel of pulse signal of the ulnar artery.

39. A device as defined in **claim 24** wherein the pressure transducer to be connected to said pressure bladder are integrated with said bladder holding device into a whole.

40. **A pulse signal processing device,** using any wrist detecting assembly defined in **Claim 24** through **Claim 39** for non-invasive blood pressure measurement, wherein comprising at least one said wrist detecting assembly which includes at least one said arterial pulse transducer array, the multiple pulse signals output from said arterial pulse transducer array are connected to a optimal pulse signal selector after amplified and filtered.

41. A device as defined in **claim 40** wherein said optimal pulse selector choose the optimal pulse signal comprising the steps of, first, choosing a

column of the pulse signal with the largest amplitude during the maximum oscillation among all the columns of the pulse signals detected from the transducers arranged parallel to the radial artery in the array; secondly, choosing a channel of the pulse signal from the selected columns of the pulse signals, said selected signal possessing not only maximum oscillation through the entire pressure changing process of the pressure bladder, but also being closed to disappearance during the bladder pressure is higher than the pressure corresponding to the maximum oscillation, and the bladder pressures corresponding to the maximum and the disappearance of oscillation of the selected signal being the lowest; finally, said selected signal being used as the optimal pulse signal.

42. A device as defined in **claim 40** or **claim 41** wherein, after the optimal pulse signal is selected, a optimal pulse transducer position displaying device is controlled to indicate the exact position of the transducer that detected optimal pulse signal in said arterial pulse transducer array.

43. A device as defined in **claim 40** or **claim 41** wherein comprising a optimal pulse transducer position warning device to issue warning signals when the transducer that detected the optimal pulse signal shifts away from the center of said arterial pulse transducer array.

44. A device as defined in **claim 40** wherein said optimal pulse selector, optimal pulse transducer position displaying device, optimal pulse transducer position warning device are integrated with said wrist detecting assembly into a whole.

45. **A non-invasive blood pressure measurement device,** using any pulse signal processing device defined in **Claim 40** through **Claim 44,** wherein comprising at least one said pressure bladder and one said wrist detecting assembly which includes at least one said pressure bladder and one said arterial pulse transducer array, the multiple pulse signals output from said arterial pulse transducer array are connected to a optimal pulse signal selector to select one channel of optimal pulse signal, said pressure bladder is connected to both the output of voltage/pressure converter and the input of a pressure transducer of a pressure feeding-measuring system, said optimal pulse signal output from said optimal pulse signal selector is connected to the input of a pulse amplitude testing device of said pressure feeding-measuring system.

46. A device as defined in **claim 45** wherein said pressure feeding-measuring system can be used to measure intermittent mean blood pressure, systolic blood pressure, and diastolic blood pressure of the radial artery based on volume oscillometric method.

47. A device as defined in **claim 45** wherein said pressure feeding-measuring system can be used to measure continuous blood pressure wave of the radial artery based on volume compensation method.

48. A device as defined in **claim 45** wherein said pressure feeding-measuring system can be controlled by a switching device to alternately measure intermittent mean blood pressure, systolic blood pressure, diastolic blood pressure and continuous blood pressure wave of the radial artery respectively based on volume oscillometric method and olume compensation method.

49. Any device as defined in **claim 45** through **Claim 48** wherein comprising two independent arterial pulse transducers, two independent pressure bladders and two independent pressure feeding-measuring system, all of which can be alternately used by a switching device to either continuously or intermittently measure blood pressure from the radial artery and the ulnar artery.

50. A device as defined in **claim 49** wherein said ulnar arterial pulse transducer is made of several parallel-connected photoelectric devices, after amplified and filtered, the ulnar arterial pulse output from said arterial pulse transducer is connected to the input of the pulse amplitude testing device of said pressure feeding-measuring system used for measuring blood pressure of the ulnar artery,.

51. A device as defined in **claim 49** wherein sharing the common parts of two independent pressure feeding-measuring system used respectively to measure blood pressure from the radial artery and the ulnar artery, said common parts are those except for said signal amplifier, filter, optimal pulse signal selector, and pulse amplitude testing device.

52. Any device as defined in **claim 49** through **Claim 51** wherein sharing one pressure feeding-measuring system for measuring blood pressure from the radial artery and the ulnar artery, and when measuring blood pressure from one of the two arteries, said pressure feeding-measuring system is controlled by a switching device to alternately connect to the tubing of said pressure bladder and the output of said arterial pulse transducer placed on the artery being measured.

53. A device as defined in **claim 49** or **claim 50** wherein comprising a calibrating device that uses the results of blood pressure measured from the radial artery to calibrate the results measured from the ulnar artery.

54. A device as defined in **claim 49** wherein said optimal pulse selector, optimal pulse transducer position displaying device, optimal pulse transducer position warning device, as well as pressure feeding-measuring system can be integrated with said wrist detecting assembly into a whole.

55. A device as defined in **claim 49** or **claim 54**wherein said non-invasive blood pressure measuring device can be integrated with a blood pressure recording device into a whole.

56. A device as defined in **claim 49** or **claim 54** or **claim 55** wherein said non-invasive blood pressure measuring device can be integrated with the monitor for measuring and recording other physiological signals into a whole.

57. Any device as defined in **Claim 49** or **Claim 54** through **Claim 56** wherein said non-invasive blood pressure measuring device can be connect to some communication devices.